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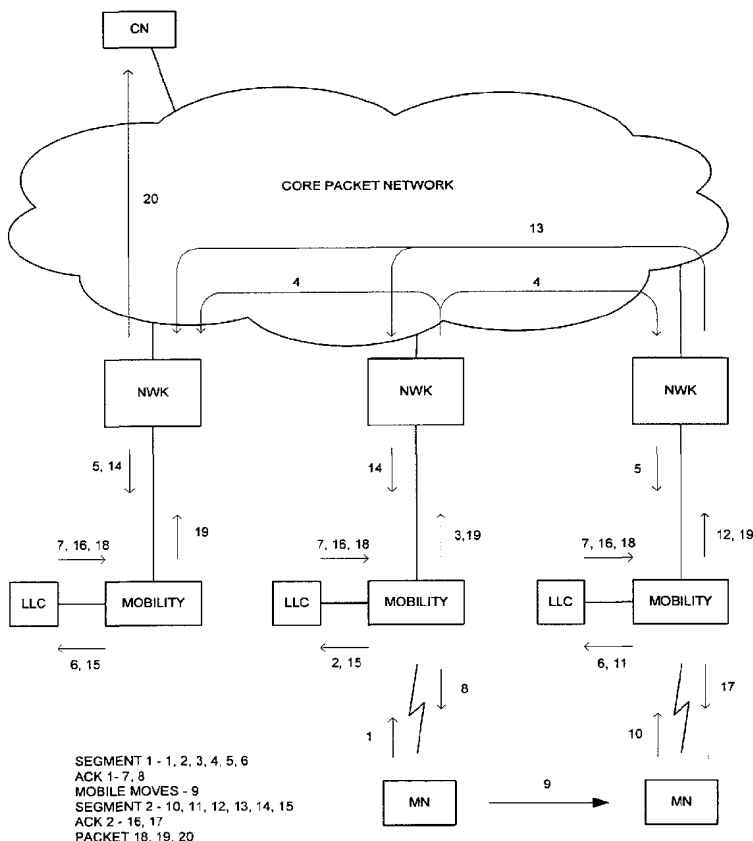
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(54) Title: MICRO MOBILITY IN COMMUNICATION NETWORKS



(57) Abstract: Mobile nodes receive services from stationary base nodes in a wireless packet network. The stationary nodes are associated in groups by which packets are forwarded to and from the mobile nodes. Each group provides services to mobiles within a geographical area. Each node in a group can transmit all or parts of an incoming or outgoing packet for a mobile node moving within the area. Parts of packets and acknowledgements are generally distributed throughout the group.



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## MICRO MOBILITY IN COMMUNICATION NETWORKS

### FIELD OF THE INVENTION

This invention relates generally to packet communication networks and particularly to wireless packet networks in which mobile nodes move in relation to stationary base nodes. The stationary nodes are generally associated in groups by which packets are forwarded to and from the mobile nodes.

### BACKGROUND TO THE INVENTION

Packet communication networks, such as the Internet, are generally based on models involving a hierarchy of layers and protocols, although these are not necessarily named in a consistent way. Layer 4, or the transport layer, is mainly responsible for end-to-end packet ordering, error correction and congestion management. Layer 3, or the network layer, defines addresses or numbering for nodes on a network, and a format for packets, sometimes called cells or datagrams, and routes these packets between nodes on different networks. Layer 2, or the data link layer, is mainly responsible for transferring data between adjacent nodes, and optionally involves segmentation of packets from layer 3 into smaller portions, management of contention for a shared medium, error correction or detection, and framing of data blocks over a physical layer. Layer 1, or the physical layer, is mainly responsible for transmitting raw data bits over the communication medium.

The functions of layer 2 are usually further divided into the LLC, or logical link control sub-layer, and the MAC, or medium access control sub-layer. The LLC is responsible for reliable transmission of packets across the communication medium, usually achieved by segmentation of large packets, retransmission of segments in which errors are detected, and flow control to ensure that segments

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are only sent at a rate such that the receiver can process them. Common LLC protocols are automatic repeat request (ARQ), go back n, and selective repeat. These protocols use combinations and variations of positive and negative acknowledgement of transmitted segments, timers in case of transmission failure, and segment numbering to ensure correct ordering of segment reconstruction and elimination of duplicate segments. The MAC is commonly in control of contention for the shared medium, grouping of data bits into frames, forward error correction, error detection and data link encryption.

Research and recommendations in relation to the Internet have generally been conducted by way of the IETF (Internet Engineering Task Force) which issues documents called Internet Drafts and RFCs (Request For Comments). Several thousand Internet Drafts and RFCs have been published on a wide range of topics. The IETF is also responsible for gradual replacement of IPv4 (IP version 4) that has been used throughout the 1980s and 1990s, by IPv6 which has expanded addressing and routing capabilities, simplification of packet headers, and several other improvements. IP limits the ability of nodes in a network to easily change their points of attachment. Each node with a new attachment must be given a new address. The limitations are inconvenient for modern users who increasingly use mobile equipment such as laptops and packet radios. RFC 2002 from October 1996 describes a mechanism which enables transparent routing of packets to mobile nodes irrespective of their point of attachment, and thereby provide support for mobile IP. An Internet Draft from November 2000 includes specific recommendations for mobile IP in relation to IPv6.

The movement of mobile nodes between base nodes has some special problems that have not yet been resolved in a satisfactory way. A mobile node such as a radio can appear to move quickly between the cells of neighbouring base nodes, depending on speed of individual movement and various local effects. As a result, handoffs between base nodes can happen several times during transmission of a

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single packet and may cause loss or delay of data. Real time transmission of data such as an ongoing voice signal is particularly sensitive to delay. In the case of a mobile IP network, rapid movements between cells can also cause unduly frequent updates of the care-of-address that must be assigned to the mobile node. Another  
5 consequence of rapid mobility is that reception of packets can be unduly delayed when they are only forwarded to new locations of a mobile node after the node has moved. It can be an advantage in packet mobility architectures if the next packet to be transmitted to a mobile node is already at a potential new location before the node arrives at that location. Several systems which attempt to  
10 overcome these difficulties are already known in the art.

It can also be an advantage, when a mobile node moves to a new point of attachment, if the new base node already knows the state of the segmentation and transmission of any outstanding packet or packets. This helps avoid delay while  
15 the new base node is updated, either by the previous base node across the core packet network, or by the mobile node itself. Knowledge of the state of the transmission ensures that transmission of the packet, whether from the mobile node to the base node or vice versa, can continue from the point it had reached with the previous base node with little further delay.

20

#### SUMMARY OF THE INVENTION

It is an object of the present invention to provide improvements relating to wireless communication networks in which mobile nodes receive services from  
25 stationary nodes, or at least to provide alternatives to existing systems. In general the invention involves groups of associated nodes which are able to transmit all or parts of incoming packets to, and receive all or parts of packets transmitted by, mobile nodes which operate within a geographical coverage area of these groups of nodes.

30

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Accordingly in one aspect the invention may broadly be said to consist in a method of assisting movement of mobile nodes in a packet communications network comprising: recognising a mobile node in relation to a group of stationary nodes in the network, receiving a packet addressed to a mobile node at one or more nodes in the group, forwarding part of the packet to the mobile node from one of the nodes in the group, receiving an acknowledgement of receipt from the mobile node of the part of the packet, and distributing the acknowledgement throughout the group.

In a further aspect the invention may broadly be said to consist in a method of assisting movement of mobile nodes in a packet communications network comprising: recognising a mobile node in relation to a group of nodes in the network, receiving a packet addressed to a mobile node at one or more nodes in the group, forwarding part of the packet to the mobile node from one of the nodes in the group, and distributing a status message regarding the part of the packet throughout the group.

In a further aspect the invention may broadly be said to consist in a method of assisting movement of mobile nodes in a packet communications network comprising: recognising a mobile node in relation to a group of stationary nodes in the network, receiving part of a packet from the mobile node at a stationary node in the group of nodes, acknowledging receipt of the part of the packet to the mobile node from the stationary node, and distributing the received part of the packet throughout the group.

In another aspect the invention may broadly be said to consist in a method of assisting movement of mobile nodes in a packet communications network comprising: recognising a mobile node in relation to a group of stationary nodes in the network, receiving part of a packet from the mobile node at a stationary

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node in the group of nodes, distributing the received part of the packet throughout the group.

5 The invention also consists in a node or a network which implements methods of this kind.

## LIST OF FIGURES

10 Preferred embodiments of the invention will be described with respect to the accompanying drawings, of which:

Figure 1 shows a network system with a group of base nodes currently serving a mobile node,

Figure 2 shows transmission cells for a group of base nodes which are associated according to likely movement of a mobile node,

15 Figure 3 shows layer entities within a base node,

Figure 4 indicates distribution of segments in a group with possible failure in numbering of the segments,

Figure 5 indicates distribution of segments in a group with success in numbering of the segments,

20 Figure 6 indicates movement of a mobile node more quickly than distribution of segments in a group,

Figure 7 indicates handover during uplink distribution of segments with acknowledgement,

25 Figure 8 indicates handover during uplink distribution of segments without acknowledgement,

Figure 9 indicates handover during downlink distribution of segments with acknowledgement,

Figure 10 indicates handover during downlink distribution of segments without acknowledgement,

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Figure 11 shows implementation of a macro-diversity system in accord with the invention, and

Figure 12 indicates functionality of the link mobility entity in Figure 3.

## 5 DESCRIPTION OF PREFERRED EMBODIMENTS

Referring to the drawings it will be appreciated that the invention may be implemented in a variety of ways, in a variety of networks, all within the scope of the specification. The systems described here are provided as examples only.

10 Skilled readers will be familiar with related aspects of packet networks and mobile communication so that details from other sources need not be given in full. Some further background information will be given in relation to Figures 1 and 2.

Figure 1 schematically shows an arrangement of base nodes BN in a network that  
15 can provide packet services to a mobile node MN. A subset or group 10 of the base nodes within the network, or all of the nodes in the case of a smaller network, are potentially in position to provide service according to mobility of the node and local propagation conditions. The mobile node is indicated as attached to one particular base node, though this is not a requirement, as the mobile node  
20 could be in simultaneous or sequential contact with a number of base nodes within the group, using techniques such as soft handover or macro diversity. The mobile node is in communication across the network with a correspondent node CN, which may be present anywhere in the system, and may be another mobile node, a base node or some other node within the packet network, or a node on  
25 some other interconnected network. Packets from the correspondent node destined for the mobile node will be delivered by the packet network to the base nodes within the current group 10, according to location of the mobile node, using mechanisms such as mobile IP that are known in the art. Within each such base node, the packets will be passed to layer 2 for transmission to the mobile  
30 node.



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Figure 2 shows an arrangement of cells for a group of associated nodes BN1-BN8, by way of example. The cells are idealised as overlapping circles 20 about respective base nodes but in practice have irregular outlines determined by their local propagation environment. The boundary of each cell represents an area within which a mobile node generally finds acceptable reception for transmissions by the respective base node and can generally receive services from that node. In regions of overlap between cells a mobile node may find equally good reception from several base nodes. Handoff between base nodes within a group can occur according to various criteria, such as link goodness measurements, generally determined in layer 2, or the mobile could be in a continuous state of handoff using soft handoff or macro diversity techniques known in the art. A packet sent by a correspondent node is delivered to each member of the group. In one possible implementation, the packet is delivered by IP multicast, using a group address. As the mobile node moves between cells in the group, all or parts of the packet may be transmitted by different base nodes, and receive separate acknowledgments from the mobile node. Similarly packets transmitted by the mobile node may be received all or in part by different base nodes in a group. Parts received by different nodes are typically reassembled at every base node within the group, generally in layer 2. A variety of mechanisms can be used to forward the received packet to the correspondent node. In one preferred implementation, one of the base nodes is a care-of-node for the mobile node and sends the completed packet with the care-of-address of the mobile node as the source address according to the requirements of IP mobility. All other members of the group discard the received packet. Alternatively, the complete packet can be forwarded by some other node in the network, such as a care-of-node, foreign agent or access router, according to the requirements of IP mobility and IP routing. The group to which downlink packets are multicast for transmission to a mobile node should track and remain approximately centered on the mobile

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node. It should not usually be possible for the mobile node to move abruptly out of the zone of cells provided by the group.

Figure 3 indicates preferred layer 2 and layer 3 aspects of a model architecture for implementing mobility features at a base node according to the invention.

Segmentation of packets is handled by an LLC entity 30 while transfer of segments between local nodes is handled by a MAC entity 31, generally as usual. Layer 3 functions are handled by a network entity 33, and these may include IP and IP mobility functions. Additional features are provided by a mobility entity 32 that interacts with the MAC, LLC and NWK entities. Each of these entities is a software sub-system implemented within generally standard hardware for a radio base station or base station controller. The mobility entity in each base node is mainly responsible for actions among members of whichever groups are currently active in relation to particular mobile nodes. The mobility entity in a base node may therefore be active for a number of mobile nodes that are present within the transmission cell of that base node, or within the transmission cells of other base nodes in the different groups to which the base node belongs. One function of the mobility entity is to update other base nodes in a group, and in turn receive updates from the other nodes in the group, regarding transmissions to and from mobile nodes which are served by the group. Each base node in a group that is currently serving a mobile node thereby maintains a record of the transmissions to and from the mobile node and is able to provide service for that node relatively quickly if required. Segments of packets that are received from a mobile node, and acknowledgements that are received from a mobile node, are transmitted throughout the current group. This assists quality of service by providing continuity and reducing delays.

Figures 4 and 5 show how segments of packets must be suitably numbered for multicast transmissions between base nodes in a group. In this example a mobile node MN receiving service from base node BN1, moves to receive service from

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BN2, while transmitting a packet having three or more segments. Both base nodes are within a common group that is serving the mobile node. The mobile is initially within the cell of BN1 and transmits segment 0 to BN1 which replies with acknowledgement 0. The mobile node then transmits segment 1 and BN1 replies with acknowledgement 1. The mobile node next moves between the transmission cells and there is a handover of service to BN2. A third segment is then transmitted by the mobile node to BN2 and further segments may follow. In each case BN1 also transmits a copy of the segment it has received, to BN2 over the core network although most of these events have not been indicated. BN1 generally multicasts a copy of each segment to each other node in the current group. In Figure 4 the segments are numbered with a modulus of two so that the first and third segments are numbered as segment 0. However, there is a delay in transmission of the first segment from BN1 to BN2, during which the mobile node transmits the third segment. BN2 mistakenly interprets the first segment, received from BN1, as a duplicate of the third segment. The latest version of the segment is then discarded and it becomes impossible to correctly assemble the full packet. In Figure 5 the segments are numbered with a modulus greater than two so that each of the three segments has a distinct number. BN2 now correctly interprets the third segment in relation to the previous segments and reassembly of the packet can proceed correctly.

Figure 6 shows how segments of a packet transmitted by a mobile node can be reordered on receipt at a base node. In this example, a mobile node MN receiving service from base node BN1 moves to receive service from BN2, while transmitting a packet having three or more segments. As before, both base nodes are within a common group that is serving the mobile node. The mobile node is initially within the cell of BN1 and transmits segment 1 to BN1 which replies with acknowledgement 1. The mobile node next moves between the transmission cells and there is a handover of service to BN2. Segments 2 and 3 are then transmitted by the mobile node to BN2 which provides respective acknowledgements. The

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acknowledgement received from BN1 confirms that segment 1 has been successfully received within the group and that the mobile node need not retransmit. The acknowledgement from BN2 for segment 2 indicates that segment 1 had not been received by BN2 at that point. Meanwhile BN1 transmits a copy of segment 1 to BN2 generally as part of a multicast throughout the group. BN2 is then able to order the three segments if required to reassemble the complete packet. Further handovers to subsequent base nodes inside the current group can proceed in the usual way. Handovers between groups can occur in accord with the invention of PCT/NZ02/00016.

Figures 7 and 8 are examples in which segments of a packet are uplinked by a mobile node MN to base nodes in a common group and then transmitted to a correspondent node CN. Entities in the base nodes have been simplified for clarity. In each case there is a handover of the mobile node between transmission of two segments to first and second active nodes. The figures represent a short period of time before, during or after which other nodes may or may not be active.

The segments are multicast within the group and the reassembled packet is eventually transmitted to the correspondent node. The packet is preferably but not necessarily assembled by each base node in the group, even though this may involve some redundancy in the case of unacknowledged transmission, because a relatively uniform system can then be implemented to accommodate both acknowledged and unacknowledged transmissions. In the implementation illustrated, one of the base nodes hosts a care-of-address for the mobile node, so that only the base node forwards the reassembled packet to the correspondent node. Alternative systems might be implemented in which any node in the group could transmit a completed packet to the correspondent node.

In Figure 7 the mobile node MN transmits segment 1 to the first active node in step 1 and the segment is then processed and multicast to the associated group in steps 2 to 6 so that each node is kept up to date. Receipt is acknowledged to the mobile node by the first active node in steps 7 and 8 and the mobile node moves

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in step 9. Segment 2 is transmitted by the mobile node to the second active node in step 10, followed by multicast and processing in steps 11 to 15. It can be seen that the LLC in the newly active node is already up to date with the state of the reassembly and acknowledgement of the packet. The new node sends an acknowledgement to the mobile node in steps 16 and 17. The full packet is assembled at each node and passed to the network layer as indicated in steps 18 and 19, and the packet is transmitted by the care-of-node to the correspondent node in step 20. In Figure 8 the steps are similar except there is no acknowledgement of the transmissions. In this implementation, all the LLCs reassemble the received packet so that the mechanism is similar to that used for acknowledged transmissions. In an alternative implementation, the received segments of the packet could be forwarded to only one BN for reassembly.

Figures 9 and 10 are examples in which a packet is downlinked to a mobile node MN from a correspondent node CN by way of base nodes in a common group. In each case there is a handover of the mobile node between transmission of two segments by first and second active nodes. There are other nodes in the group which may or may not be active after this short interval. In Figure 9 the packet is forwarded to each active node in the group in steps 1 to 4. Segmentation takes place at each node in step 5 and segment 1 is transmitted to the mobile node by the first active node in step 6. An acknowledgement is transmitted by the mobile node in step 7 and multicast around the group in steps 8 to 11. The mobile node moves in step 12 and receives segment 2 from the second active node in steps 13 and 14. It can be seen that having received the multicast acknowledgement in step 11, each LLC throughout the group, and in particular the LLC in the newly active node, already knows which segment should be transmitted to the mobile node in steps 13 and 14. An acknowledgement is transmitted in step 15 and multicast throughout the group in steps 16 to 19. The mobility entity in each node indicates complete transmission of the packet in steps 20 and 21, and segmentation of a further packet is initiated in step 22. In Figure 10 the steps are similar except

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there is no acknowledgement of transmission by the mobile node. In order to keep the LLCs throughout the group synchronised in anticipation of a movement by the mobile node, the mobility entity in the currently active node multicasts a “next” indication throughout the group in steps 7 to 9, and this indication is  
5 passed on to the LLC in step 10. In this way, when the mobile node moves to a new base node in step 12, the new LLC already knows which segment should be transmitted next in step 13.

A micro-mobility architecture of this kind can be used to support macro-diversity  
10 methods, as illustrated in Figure 11. In a macro-diversity system, cell sites are arranged such that transmissions by the MN can commonly be heard by more than one site at a time. A MN in such a position is commonly referred to as being “in soft handover”. The transmissions received at each site must be gathered at some central point, where they will be recombined to extract the original data. This  
15 process of recombination might vary in complexity, from a simple selection of the best frame received, to a mathematical recombination of captured modulation symbols. Likewise, downlink transmissions by the infrastructure might be duplicated across a number of sites, giving the MN multiple opportunities to receive the data. To avoid these multiple downlink transmissions interfering with  
20 each other at the MN, they might be separated in time through different downlink slots, or by code in the case of a CDMA system. In either case, downlink diversity does carry the penalty of increased consumption of spectrum for the transmissions, though this might be offset by a reduced need for error correction or retransmissions.

25

In Figure 11 a transmission by the MN in step 1 is received, entirely or in part, at SC2 and SC3. The MAC at each of these sites should be able to determine which link or packet the transmissions belong to. This information might be encoded in a MAC header (that must be successfully received at each site), or the MAC might  
30 be able to deduce which link a received transmission belongs to according to the

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physical channel (frequency + time slot + CDMA code) on which it was received.

The MAC on each site that receives a transmission passes it up to the link mobility entity LME as normal. In steps 2, 3, and 4, each LME multicasts the received data to the current simulcast group, just as in the non-diversity case. The data that is  
5 multicast might include digitised modulation information, demodulated bits, or entire frames, according to the diversity recombination process that is being used. Once this is done, every LME in the group has exactly the same information.

Diversity recombination is carried out in step 5. It is immaterial in this  
10 architecture whether the recombination is carried out at the modulation symbol, demodulated bit, or MAC frame level. In any case, after diversity recombination, the segment transmitted by the MN LLC will become available. This segment is passed to the LLC in each site at step 6. As the LLC in every site in the group is working with exactly the same information, they will all produce an identical  
15 acknowledgment at step 7. This acknowledgment is passed to the LME, which transmits it on the downlink in step 8 according to the chosen downlink diversity scheme.

In the case illustrated in Figure 11, the segment shown is the last one required to  
20 complete the reassembly of a packet. In steps 9 and 10 the packet is passed from the LLC to the LME and then the NWK layer in every site. Under a possible macro-mobility architecture, only the primary SC will forward the packet across the core network to the correspondent node, as shown in step 11. The same mechanism can be used for downlink transmission of packets, in which it is the MN's  
25 acknowledgments that will be multicast and recombined at each site, and for unacknowledged transfer of uplink packets, in which no acknowledgment will be transmitted on the downlink.

This architecture for macro-diversity works with our proposed micro-mobility  
30 architecture. One addition for macro-diversity is the presence of the diversity

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recombination process, and the downlink diversity mechanism if one is used. In the conventional handover case discussed earlier in this document, only one site might make the multicast transmission, and only one LME will pass packet segments or acknowledgments down to the MAC for transmission to the MN. The multicast and diversity recombination processes will impose a delay on the reception of packet segments. The LLC mechanism that is used must be able to cope with this delay. This might require the use of a mechanism such as selective repeat, rather than a simpler mechanism such as ARQ.

Figure 12 sets out many of the functions that can be carried out at a base node by the mobility entity in Figure 3. It should be noted however, that routing of packets and segments can be achieved without explicitly including such an entity in the architecture, as many of the functions could be carried out by functionality in the network layer, the LLC and the MAC.

The link mobility entity can receive a segment or an acknowledgement from the MN, either over the air via the lower layers of the protocol stack, or by multicast from other group members. A segment will be received from the MN when the MN is transmitting a packet onto the network on the uplink, and an acknowledgement will be received when the MN is receiving a packet on the downlink. The segment may be part of the packet, or it might be the whole packet.

If the link mobility entity is working as part of a macro-diversity system, then an attempt will be made to decode the received segment or acknowledgement using the chosen diversity recombination method. In some systems, the mobility entity might have to wait until it has received a number of copies of the segment or acknowledgement from multiple sites before it attempts to reconstruct the received data. In Figure 12, the mobility entity will attempt a diversity recombination each time a copy of the segment or acknowledgement is received.



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Not included is the purging of segments or acknowledgements that have not been successfully recombined after a certain amount of time.

Whenever a segment or acknowledgement is received, it will be passed to the local  
5 LLC entity. The LLC uses this information either to reassemble the original packet, or to determine the next segment of the packet that should be transmitted. If the segment or acknowledgement has been received over the air at this site, then the mobility entity will forward it to the other sites in the same group, allowing their mobility entities to perform the same process.

10 When the LLC passes a new segment or acknowledgement to the mobility entity for transmission to the MN, the mobility entity will pass it to the lower layers for transmission only if the MN is active on this site. In a conventional handover system, the MN is active on only one site at a time. In a macro-diversity or soft  
15 handover system, this same segment or acknowledgement might be transmitted by multiple sites.

When the LLC has succeeded in reassembling a complete packet, it is passed to the network layer for forwarding to the correspondent node.

20 Packets that arrive from a correspondent node for transmission to an MN are passed down to the link mobility entity by the network layer. The link mobility entity passes these to the LLC for segmentation. In an alternative implementation, packets might be passed directly between the LLC and the network layer, in either  
25 direction, without going via the mobility entity.

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## CLAIMS:

1. A method of assisting movement of mobile nodes in a packet communications network comprising:

5 recognising a mobile node in relation to a group of stationary nodes in the network,

receiving a packet addressed to a mobile node at one or more nodes in the group,

10 forwarding part of the packet to the mobile node from one or more of the nodes in the group,

receiving an acknowledgement of receipt from the mobile node of the part of the packet, and

distributing the acknowledgement throughout the group.

15 2. A method according to claim 1 further comprising:

forwarding another part of the packet to the mobile node from one or more other of the nodes in the group,

receiving another acknowledgement of receipt from the mobile node of the other part of the packet, and

20 distributing the acknowledgement throughout the group.

3. A method according to claim 2 further comprising:

handing over the mobile node between nodes in the group between forwarding the parts of the packet to the mobile node.

25

4. A method according to claim 1 further comprising:

receiving the acknowledgement of receipt at one or more of the stationary nodes from which the part of the packet was forwarded.

30 5. A method according to claim 1 wherein:

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each node in the group has substantially equivalent capability for reception and transmission of packets.

6. A method of assisting movement of mobile nodes in a packet  
5 communications network comprising:

recognising a mobile node in relation to a group of nodes in the network,  
receiving a packet addressed to a mobile node at one or more nodes in  
the group,

forwarding part of the packet to the mobile node from one or more of the  
10 nodes in the group, and

distributing one or more status messages regarding the part of the packet  
throughout the group.

7. A method according to claim 6 further comprising:

15 forwarding another part of the packet to the mobile node from one or  
more other of the stationary nodes, and

distributing one or more other status messages regarding the other part  
of the packet throughout the group.

20 8. A method of assisting movement of mobile nodes in a packet  
communications network comprising:

recognising a mobile node in relation to a group of stationary nodes in the  
network,

receiving part of a packet from the mobile node at one or more stationary  
25 nodes in the group,

acknowledging receipt of the part of the packet to the mobile node from  
the stationary nodes, and

distributing the received part of the packet throughout the group.

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9. A method according to claim 8 further comprising:  
receiving another part of the packet from the mobile node at one or more  
other stationary nodes in the group of nodes,  
acknowledging receipt of the other part of the packet to the mobile node,  
5 and  
distributing the other received part of the packet throughout the group.

10. A method according to claim 8 wherein:  
the acknowledgement includes information in relation to previous parts  
10 of the packet.

11. A method according to claim 8 further comprising:  
handing over the mobile node from one stationary node to another  
stationary node between receiving the parts of the packet from the mobile node.

12. A method according to claim 8 further comprising:  
assembling the packet at one or more nodes in the group, and  
forwarding the packet to a destination as required by the mobile node.

13. A method according to claim 8 wherein:  
each node in the group has substantially equivalent capability for  
reception and transmission of packets.

14. A method of assisting movement of mobile nodes in a packet  
25 communications network comprising:

recognising a mobile node in relation to a group of stationary nodes in the  
network,

receiving part of a packet from the mobile node one or more stationary  
nodes in the group,

30 distributing the part of the packet throughout the group.

15. A method according to claim 14 further comprising:  
receiving another part of the packet from the mobile node at or more  
other stationary nodes in the group of nodes, and  
5 distributing the other part of the packet throughout the group.

16. A method according to claim 15 further comprising:  
assembling the packet at one or more nodes in the group, and  
forwarding to a destination as required by the mobile node.

17. A method of assisting movement of mobile nodes in a packet  
communications network comprising:

recognising a mobile node in relation to a group of stationary nodes in the  
network,

15 receiving a packet addressed to a mobile node at one or more nodes in  
the group,

forwarding part of the packet to the mobile node from one or more nodes  
in the group,

receiving part of an acknowledgement of receipt from the mobile node at  
20 one or more nodes in the group, and

distributing the part of the acknowledgement throughout the group.

18. A method according to claim 17 further comprising:

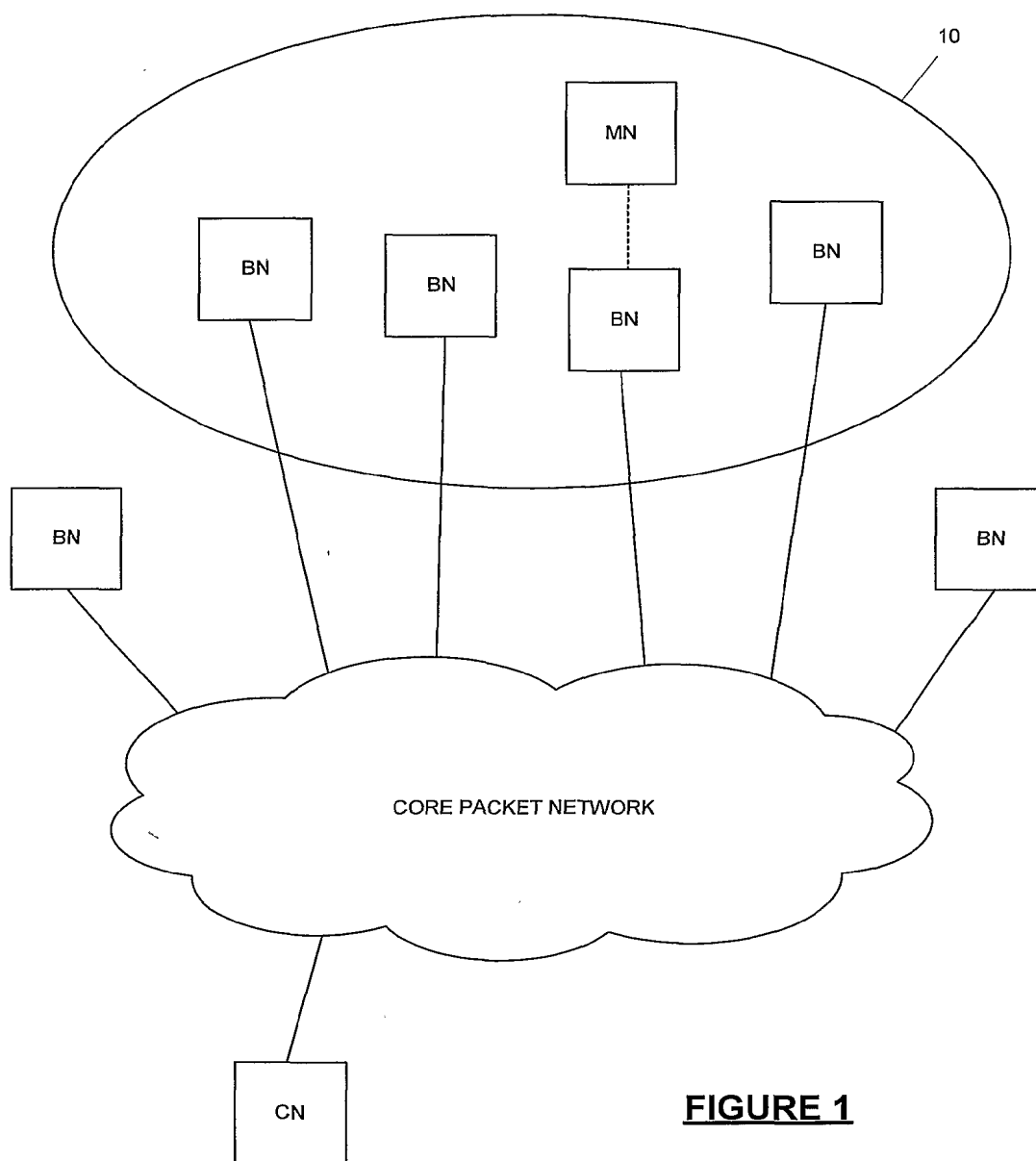
receiving other parts of the acknowledgement of receipt from the mobile  
25 node at one or more nodes in the group,

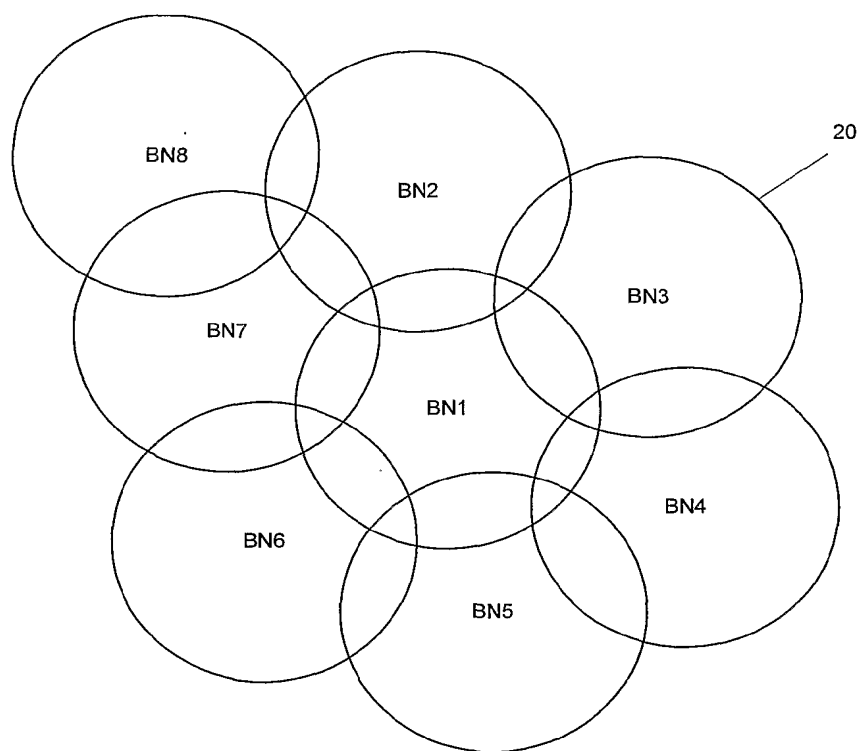
distributing the other parts of the acknowledgement throughout the  
group, and

combining the parts of the acknowledgement to form a complete  
acknowledgement of receipt of the part of the packet.

- 20 -

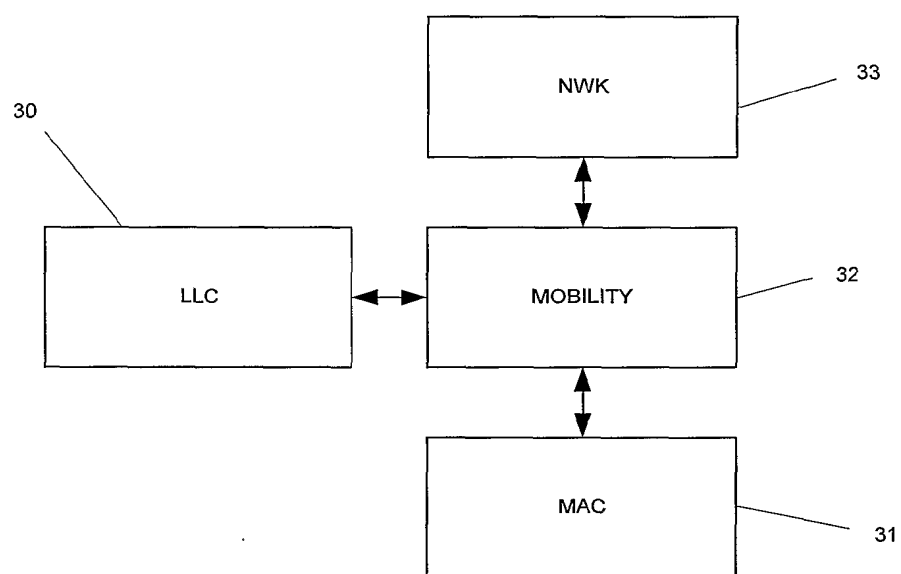
19. A method according to claim 17 further comprising:  
forwarding other parts of the packet to the mobile node from one or more  
of the nodes in the group,  
receiving parts of further acknowledgements of receipt from the mobile  
5 node at one or more nodes in the group, and  
combining the parts of the further acknowledgements to form complete  
acknowledgements for each part of the packet.
20. A communications network that implements a method according to any  
10 one of the preceding claims.
21. A node for a communications network that implements a method  
according to any one of the preceding claims.

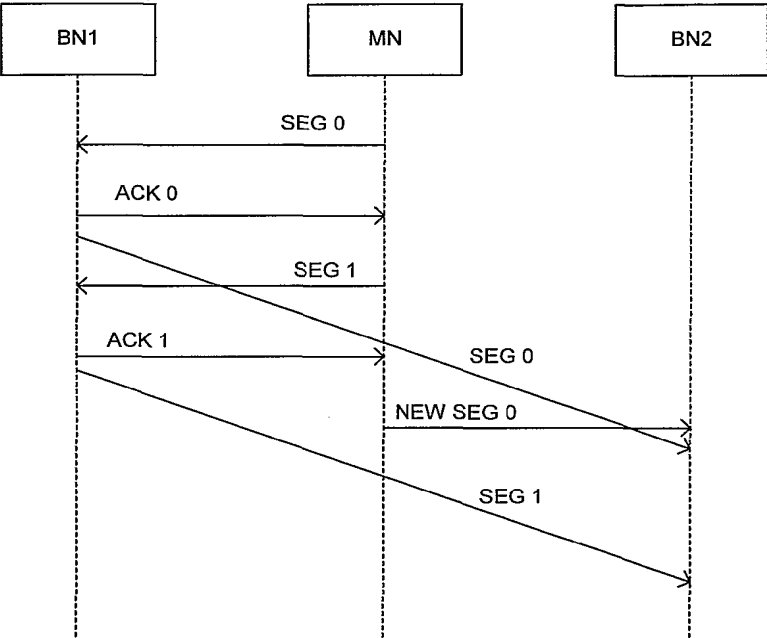
**FIGURE 1**



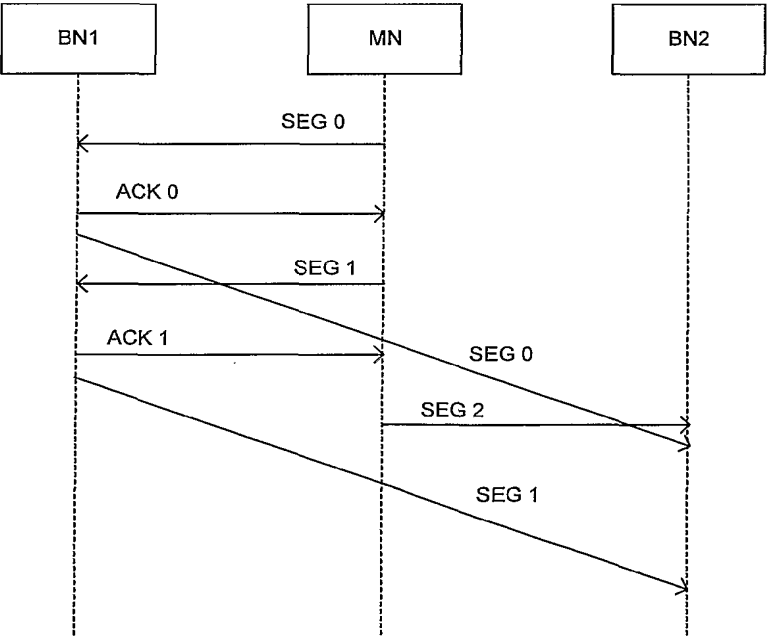
**FIGURE 2**



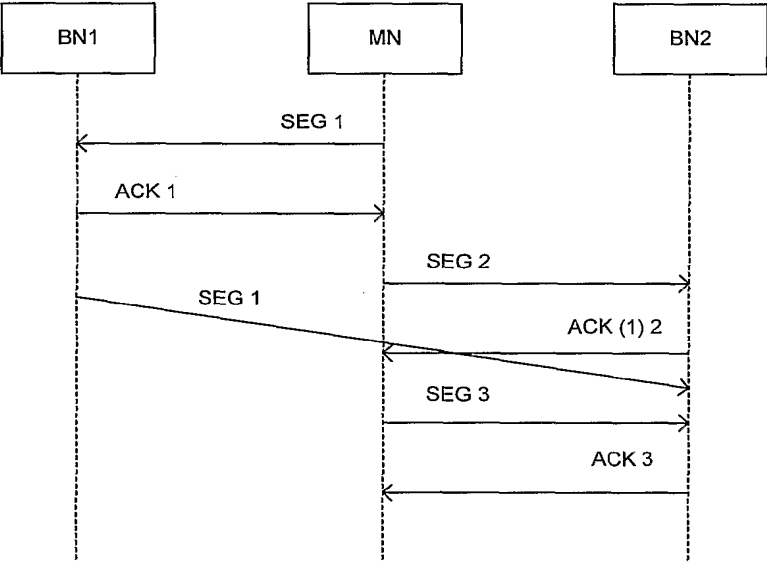
**FIGURE 3**



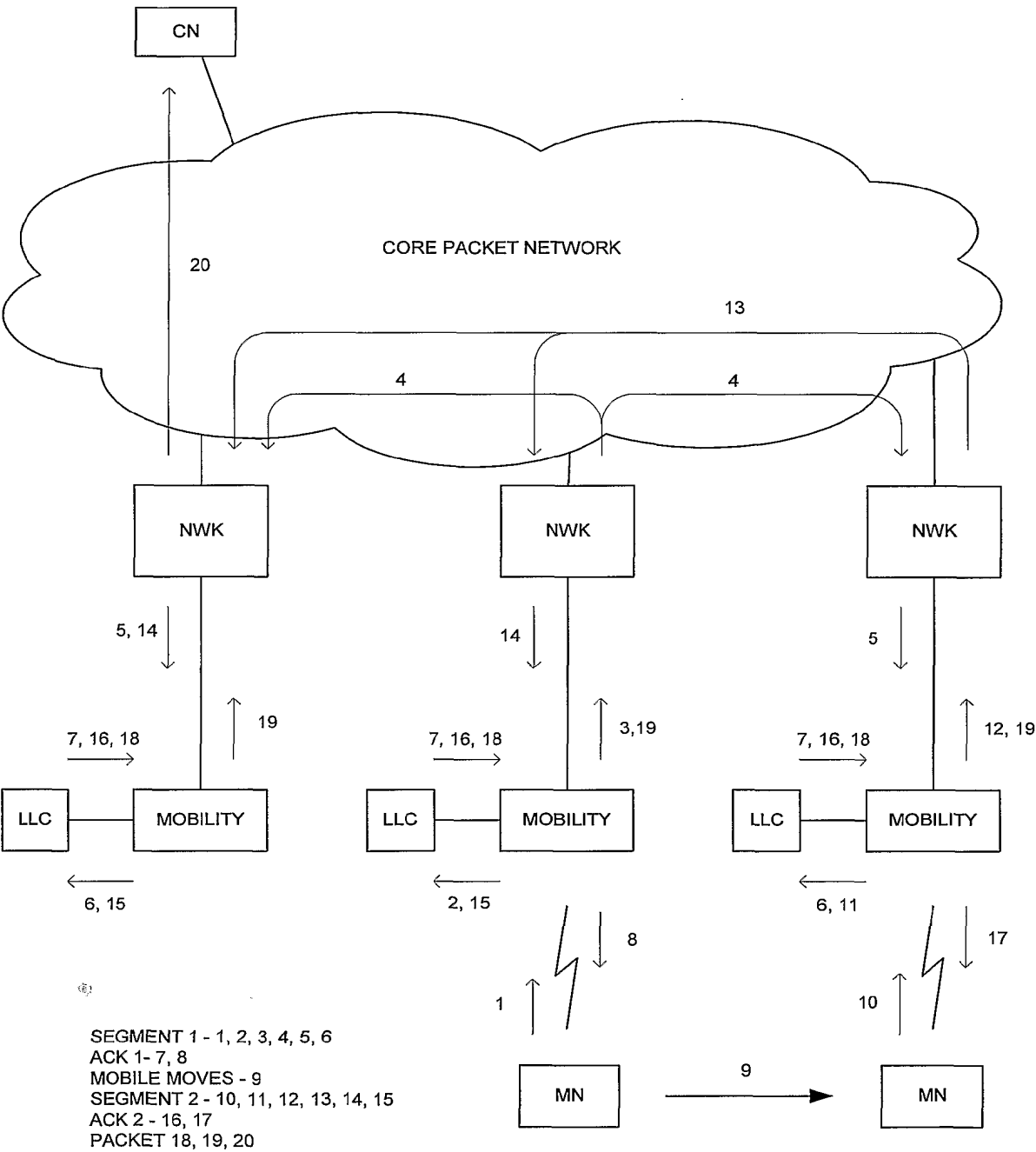
**FIGURE 4**



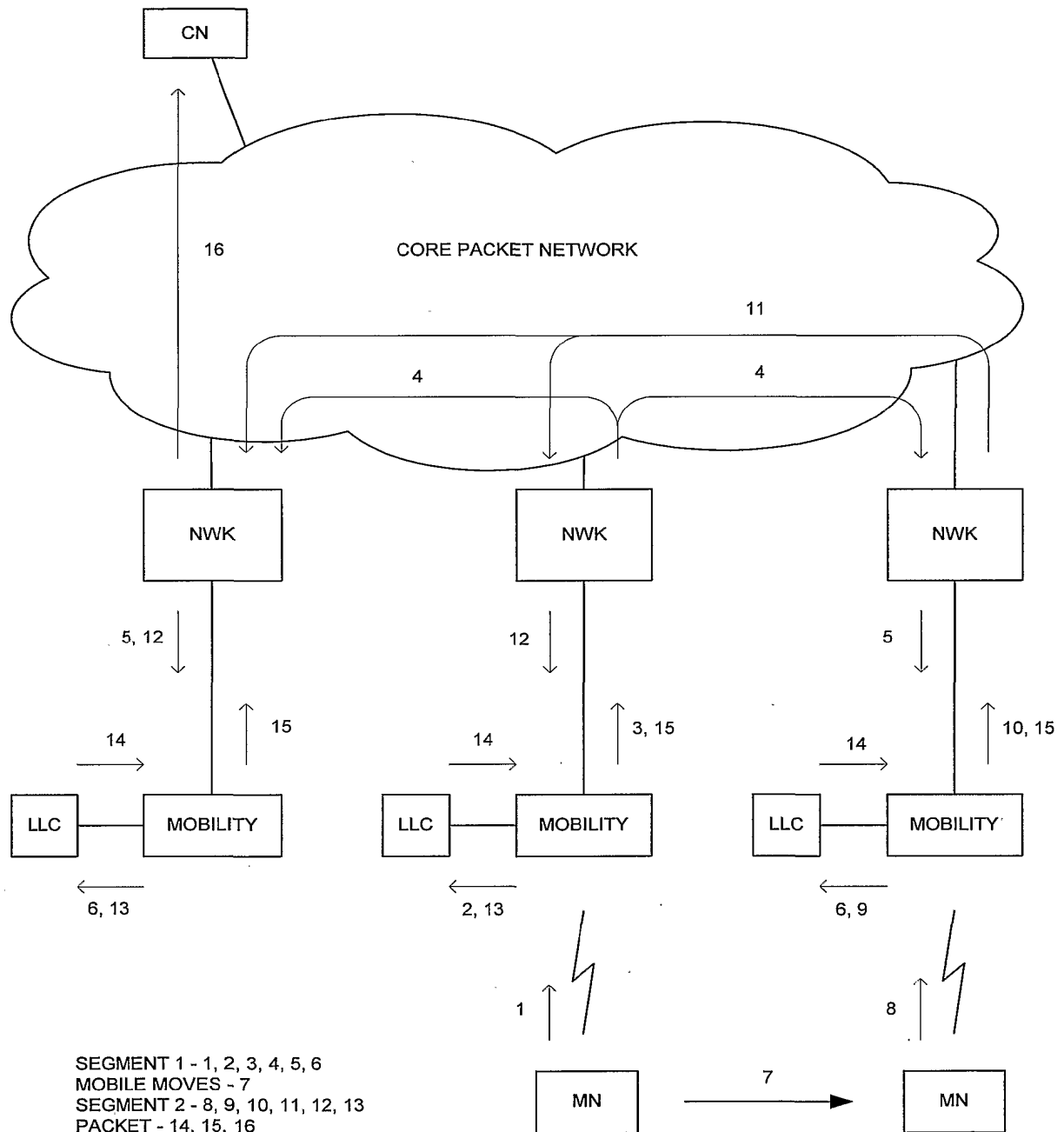
**FIGURE 5**

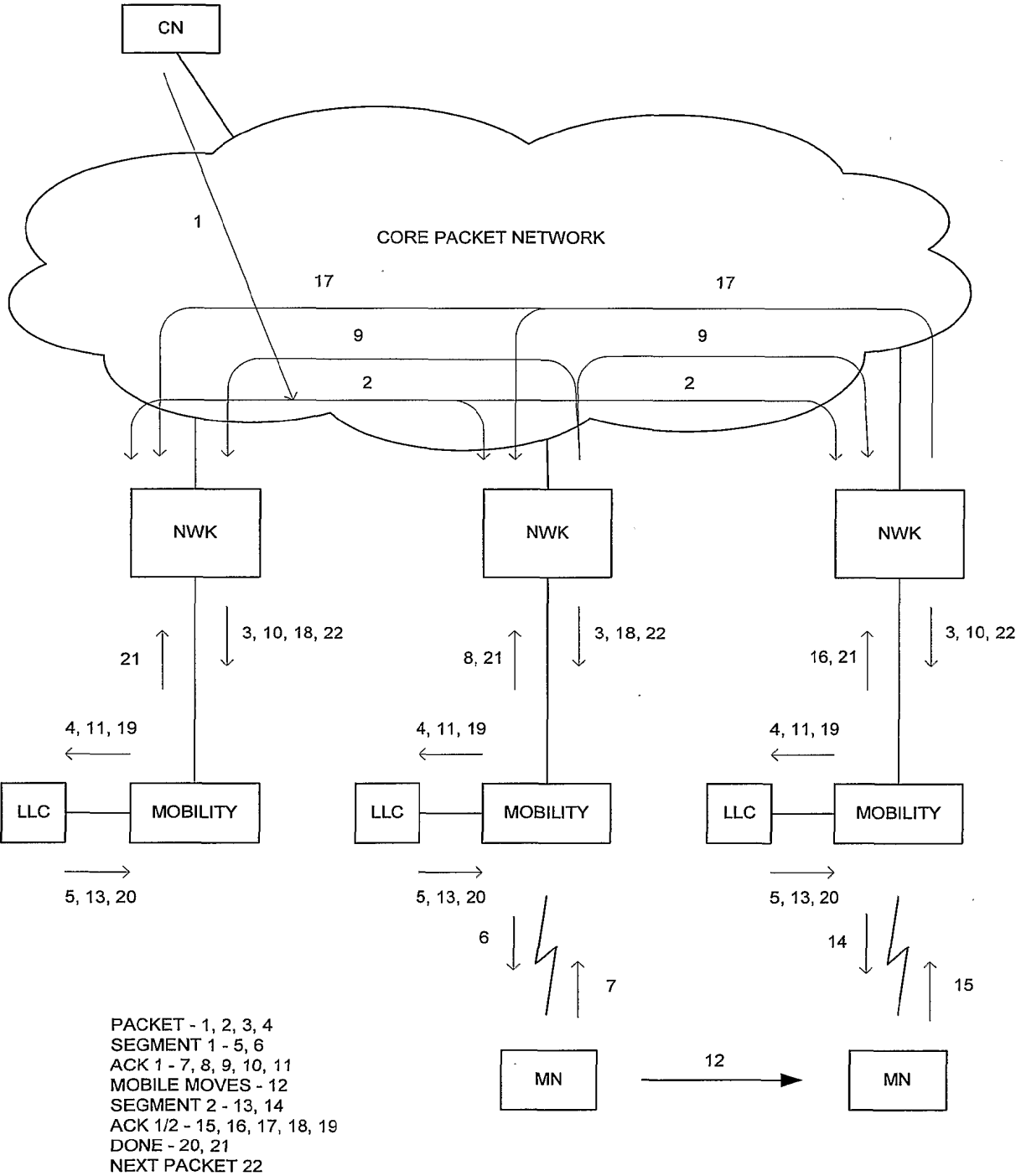


**FIGURE 6**

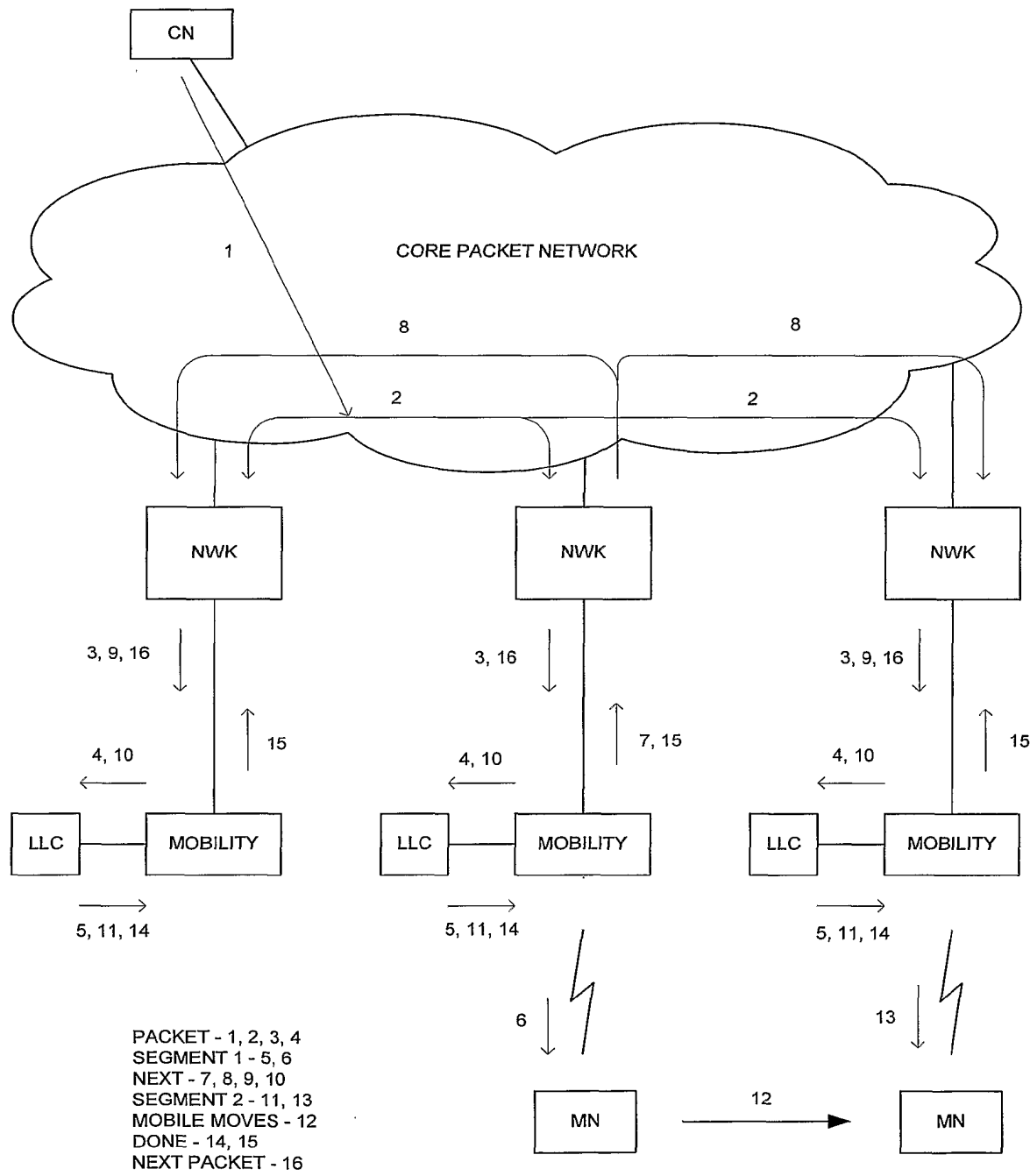


**FIGURE 7**

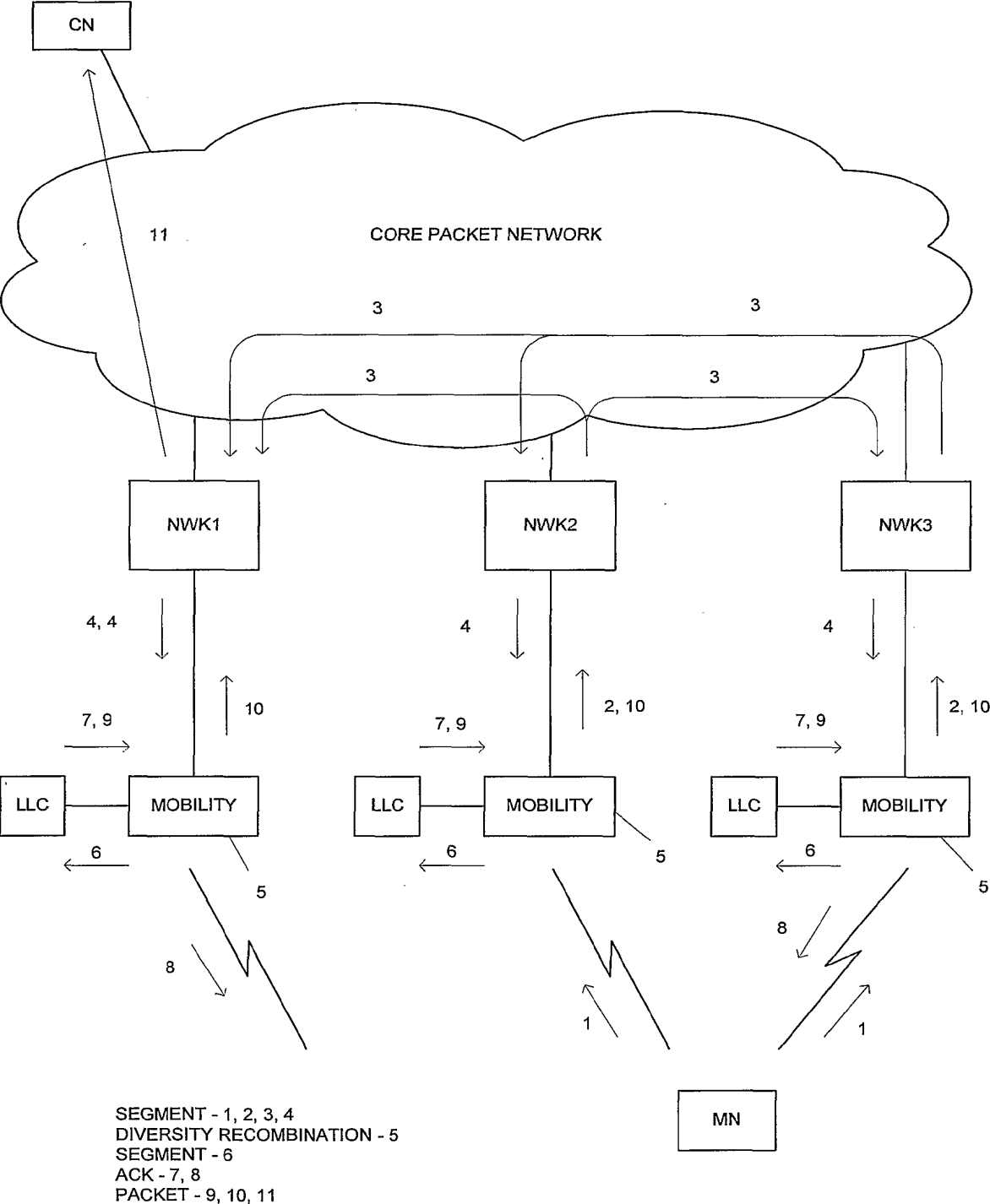
**FIGURE 8**



**FIGURE 9**



**FIGURE 10**



**FIGURE 11**



Event	Action
Segment or acknowledgement received, either from the MS over the air, or from another site over the core network	If (this is a macro-diversity system) { Attempt to decode the received segment, according to the chosen diversity recombination method } If (segment received or decoded successfully) { Pass segment or acknowledgement to LLC } If (segment received over air at this site) { Forward segment or acknowledgement to all group members }
Acknowledgement or segment received from the LLC, to be sent over the air	If (MS active on this site) { Transmit acknowledgement or segment to MS }
Reassembled packet received from LLC	Pass complete packet up to network layer, for forwarding to correspondent node
Packet received from network layer for transmission	Pass packet to LLC for segmentation

**FIGURE 12**